Defining the elements for successful implementation of a small-city radiotherapy department

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ABSTRACT

Aims

Distributed delivery models for cancer care have been introduced to bring care closer to home and to provide better access to cancer patients needing radiotherapy. Very little work has been done to demonstrate the elements critical for success in a non-centralized approach. The present study set out to identify the elements that are important for implementing radiotherapy away from large cities.

Methods and Results

This qualitative research project consisted of two separate components. In the first component, structured interviews were conducted with 5 external experts. Input on the expert responses was then sought from internal leaders in medical physics, radiation therapy, and radiation oncology. Those interviews were used to develop a proposed template of the elements needed in a small-city department. We tested the validity of all elements by surveying staff members from the radiation treatment program in Calgary, leading to a definition of the resources needed for the proposed department in Lethbridge. Seventy-five staff members contributed to the survey.

Conclusions

Qualitative research methods allowed us to define important elements for a small-city radiotherapy department and to validate those elements with a large cohort of staff working in a tertiary centre. This work has influenced the planning of a small-city department in Lethbridge, emphasizing the importance of the elements identified to the service planners. We await the completion of the construction project and the opening of the centre so that we can re-evaluate the importance of the identified elements in actual practice. We recommend such an approach to jurisdictions that are considering devolved radiotherapy.

KEY WORDS

Qualitative research, radiotherapy, access

1. INTRODUCTION

Centralized care has been the mainstay of radiotherapy service delivery in Canada for more than four decades [1]. "Centralized care" can be defined as a service that is readily accessible only to patients living close to larger cities, but that provides access to all patients willing to travel [2]. In practical terms, use of this approach has meant that a significant proportion of cancer patients in countries such as Canada have had to travel for more than 3 hours to reach a city with radiotherapy facilities. Health ministries argue that this model is justified because quality radiotherapy services are not viable outside bigger cities.

In the late 1990s, concerns were expressed about the centralized model because of the poorer outcomes seen in cancer patients living in smaller communities [1,3]. Although these poorer outcomes were previously considered to be related mostly to the prevalence of more advanced disease in the smaller communities, data now link poorer outcomes with a lack of appropriate treatment closer to home, probably directly associated with lower utilization of radiotherapy [4]. As a result of those findings, several Canadian provinces have expanded services to smaller cities [5,6].

Efforts to decentralize radiotherapy have been made by British Columbia, Nova Scotia, Ontario, Manitoba, and Quebec. In 2005, we evaluated access to radiotherapy in Alberta and found that 28% of cancer patients needing radiotherapy in the province had to travel more than 100 km from home to receive treatment [6]. In 2007, the province announced its decision to distribute radiotherapy to 3 small cities,

prompting us to ask whether there was clarity about the type of department practical for such cities. We sought opinions from several external experts on the issues that we were considering, and we received input from internal staff on their perspectives about the resources needed for such a department. The present report constitutes our findings from these separate initiatives.

We had at least 3 objectives for this study:

- To evaluate service-delivery models in radiotherapy
- To establish the preferred model from a tertiary centre perspective, with input from professionals in radiation medicine in Calgary
- To use internal and external experts in describing and analyzing the factors that might challenge successful implementation of such a model

2. METHODS

This qualitative study used mixed methods, with a grounded-theory approach [7]. Our main objective was to examine and respond to concerns about staffing in small radiotherapy departments. A "small department" was defined as an operation that proposes to function with no more than 2 linear accelerators.

The research group, consisting of a radiation oncologist, a medical physicist, and a radiation therapist, used evidence to formulate elements within draft delivery models for small-city departments. Semi-structured interviews with leaders and external experts were used to define the factors that could assist in implementation of a small-city department. A survey mechanism tested the relevance of those factors to staff in a tertiary-centre radiotherapy department linked to a university. Staff were also made aware of the perspectives of the external experts.

2.1 Evaluation of Alternative Service Delivery Models to Be Considered

We proposed 3 theoretical models of care to illustrate the practical implications of service delivery (Tables I and II). Certain Canadian centres that approximated those definitions were cited to make the model easier for survey participants to grasp. Using tumour site data from Alberta, we proposed a proportion of patients to consider for treatment in each of the delivery models:

- ***Tertiary model*** (for example, Calgary or Edmonton), with an academic focus, with all technical and professional services for radiotherapy available, and with 100% of patients able to receive treatment locally
- ***Basic model*** (for example, Charlottetown, Prince Edward Island), with palliation as the main focus,

TABLE I Service delivery models

	Workload models for radiotherapy services		
	Distributed		*Tertiary*
	Basic	*Developed*	
Sites offered			
Breast	√	√	√
Lung	√	√	√
Prostate	√	√	√
Gynecologic	√	√	√
Bladder	√	√	√
Colon	√	√	√
Rectum	√	√	√
Re-treat (all sites)	√	√	√
Head and neck	×	√	√
Esophagus	×	√	√
Testis	×	√	√
Central nervous system	×	√	√
Stomach	×	√	√
Pancreas	×	√	√
Lymphoma	×	√	√
Myeloma	×	√	√
Liver	×	√	√
Kidney	×	√	√
Melanoma	×	√	√
Gall bladder	×	√	√
Thyroid	×	√	√
Primary unknown	×	√	√
Leukemia	×	×	√
Other	×	√	√
Special procedures			
3D CRT (as required)	√	√	√
IMRT	×	√	√
Brachytherapy	×	×	√
Stereotactic radiosurgery	×	×	√
Total body irradiation	×	×	√
On-call service	√	√	√
Capital equipment			
Dual-energy linear accelerators	√	√	√
Simulator facilities	√	√	√
Dosimetry facilities	√	√	√
Darkroom	√	√	√
Deep no-ray	×	×	√
Brachytherapy	×	×	√

3D CRT = 3-dimensional conformal radiotherapy; IMRT = intensity-modulated radiotherapy; IGRT = image-guided radiotherapy.

TABLE II Examples of the service delivery models

	Distributed		*Tertiary*
	Basic	*Developed*	*Tom Baker Cancer Centre, Alberta*
	Charlottetown, Prince Edward Island	*Sydney, Nova Scotia*	
Sites offered			
Pelvis	√	√	√
Breast	√	√	√
Lung	√	√	√
Palliative (all sites)	√	√	√
Neurologic	√	√	√
Head and neck	√	√	√
Lymphoma	√	√	√
Skin	√	√	√
Esophagus	√	√	√
Pediatric	√	√	√
Specialty procedures			
3D CRT (as required)	√	√	√
IMRT	×	×	√
IGRT	×	×	√
Brachytherapy	×	×	√
Stereotactic radiosurgery	×	×	√
Total body irradiation	×	×	√
On-call service	√	√	√
Patient courses (*n*/year)	451	426	2940
Access for local patients (%)	97	80	100
Capital equipment			
Linear accelerator energies	1	1	8
Cobalt units	1	1	1
Dedicated CT unit	1	1	2
Conventional simulator	0	0	1
Darkroom	1	1	1
Deep no-ray	0	0	1
Dosimetry terminals	3	3	7
Human resources			
Radiation oncologists on site	1	1	14.8
Clinical associates	1	1	0.8
Radiation therapists (treatment)	4	4	37
Radiation therapists (preparation)	3	3	16.5
Medical physicists	2	2	10
Technical equipment officers	1	1	4
Registered nurses	1.5	1.5	5.4
Clerical support	1	1	6
Department managers	0	0	3

3D CRT = 3-dimensional conformal radiotherapy; IMRT = intensity-modulated radiotherapy; IGRT = image-guided radiotherapy; CT = computed tomography.

but with some radical patients from that region, and with 77% of patients able to receive treatment locally [such a facility could have mobile or permanent equipment to meet patient needs—for example, computed tomography (CT) simulation or linear accelerator]
- ***Developed model*** (for example, Sydney, Nova Scotia), with most radical and palliative treatments being delivered regionally, and with 90%–95% of patients able to receive treatment locally (requires permanent equipment to be stationed at the centre)

From census and utilization data, we then developed potential patient numbers for Lethbridge, a city in southwest Alberta that provides medical services to a large area of southern Alberta and eastern British Columbia. This city had already been chosen by the province as the first of the 3 small-city radiotherapy sites. Census, cancer incidence, and registry data for 2005 allowed us to estimate the number of new cancers and the potential radiotherapy workload (total sessions per year).

Workload was calculated using an evidence-based estimate utilization model and average national caseload figures:

Predicted workload (total fractions treated in 2005) = census count × average incidence rate × 45% (utilization estimate) × 16 (national average of fractions per patient in 2005) × proportion allocated for the model.

We checked the accuracy of this model by comparing the predicted workload with numbers of patients actually treated from the regional counties around Lethbridge in 2005. Based on workload, equipment and staff requirements for the 3 models could then be calculated.

In the basic and developed models, an assumption is made that brachytherapy and stereotactic radiotherapy will continue at tertiary sites. Physical equipment needs for the 2 distributed models were calculated using Alberta ministry of health ratios (1 linear accelerator per 350 new patients treated annually and 1 simulator per 1200 new patients treated annually).

The Canadian national manpower guidelines proposed by Podgorsak in 1999 [8] were used to generate a staff table for the basic and developed models. We also calculated staff and equipment needs to retain the centralized model in Calgary rather than to move the service to Lethbridge, which gave staff an opportunity to choose whether they supported the development of basic and developed models, and also allowed for comparisons between the resources needed to establish new departments or to expand existing services.

2.2 Evaluating Staff Perspectives: Survey

Using equipment and staffing tables developed as described earlier, we created a survey tool (Table III) to evaluate perceptions of the models by staff in the radiation treatment program in Calgary. The survey was distributed to staff members of the radiation services program in Calgary who attended a town hall meeting in 2006. We invited discussion of the merits of a distributed model, and comments were recorded. The major focus of this effort was to evaluate staff perspectives on the personnel requirements for the 3 models. The aim was to assess concurrence with personnel guidelines from the Canadian national society, and whether staff numbers changed with the model type. Staff that completed the survey did so anonymously and placed the completed forms into closed ballot boxes. The results of the survey were collated in an Excel spreadsheet (Microsoft Corporation, Redmond, WA, U.S.A.).

2.3 Defining the Themes that Affect the Operations of a Small-City Radiotherapy Department

Using the survey and comments from the town hall meeting, we held semi-structured focus group discussions with leaders in radiation oncology, medical physics, and radiation therapy in Calgary and Edmonton. Structured interviews also were held with 4 external experts (Table IV), who were asked these questions:
- Is there sufficient evidence to safely move radiotherapy into small cities?
- Are there concerns about doing this in Alberta?
- What are the barriers to such a development?
- Are there experiences in other provinces or countries from which we could learn?

Using the outcomes of these discussions, we generated a list of the issues likely to affect a distributed-care initiative in radiotherapy and collated them into themes. We considered themes to be significant if 3 or more of the external experts commented on the particular issue and if the internal leaders had also mentioned it.

2.4 Synthesis Methods

The qualitative answers to the survey were synthesized in an Excel spreadsheet. Descriptive fields were analyzed using the Access database software (Microsoft Corporation). Using the survey results, average and median staffing numbers for medical physics, radiation oncology, radiation therapy, and treatment preparation (simulation and dosimetry) were calculated for each of the 3 models. Standard deviations were calculated, and the Student *t*-test was used to make statistical comparisons between the survey averages and those found in the national society recommendations.

TABLE III Survey conducted May 2006

Access to radiation therapy: modeling the provisions of a distributed service

Hypothetical situation

In a large geographic area there is one publicly funded, comprehensive, tertiary cancer centre, responsible for delivering all aspects of cancer care. This centre, over the decades, has grown into a large leading-edge academic cancer centre. Although some components of service delivery have successfully been distributed throughout the geographic area to enhance access, one major modality, radiation therapy, remains centralized, forcing patients to travel for hours to receive this treatment. This centre is limited in its ability to expand over the next 6 years, although workload is expected to increase by almost 30% over that time.

A demographic study has confirmed that there are a significant number of patients in an urban centre 2 hours' drive away from the tertiary centre. A 4-hour drive each day is more than most patients would undertake for a fractionated course of treatment. Demand in the urban centre is sufficient to fully utilize up to 2 MV units depending on the workload model. Two different models of service delivery have been created for consideration. We also consider different levels of demand, that is, courses required per year.

Proposed distributed models

	Distributed model type	
	Basic	*Developed*
Sites offered		
Breast	√	√
Lung	√	√
Prostate	√	√
Gynecologic	√	√
Bladder	√	√
Colon	√	√
Rectum	√	√
Palliative (all sites)	√	√
Head and neck	×	√
Esophagus	×	√
Testis	×	√
Central nervous system	×	√
Stomach	×	√
Pancreas	×	√
Lymphoma	×	√
Myeloma	×	√
Liver	×	√
Kidney	×	√
Melanoma	×	√
Gall bladder	×	√
Thyroid	×	√
Primary unknown	×	√
Pediatric	×	×
Leukemia	×	×
Other	×	√
Specialty procedures		
3D CRT (as required)	√	√
IGRT	√	√
IMRT	×	√
Brachytherapy	×	×
Stereotactic radiosurgery	×	×
Total body irradiation	×	×
On-call service	√	√
Patient courses (*n*/year)	541	704

TABLE III Continued

Proposed distributed models

	Distributed model type	
	Basic	*Developed*
Access for local patients (%)	77	97
Capital equipment		
Dual-energy linear accelerators 2005/2015	1.0	2
Simulator facilities	√	√
Dosimetry facilities	√	√
Darkroom	√	√
Deep X-ray	×	×
Brachytherapy	×	×

Potential staff numbers for distributed models

Using the course numbers and technical options being offered in models one and two on the previous page, assign the human resources required for each model when considering your own scope of practice. For example, radiation oncologists comment on radiation oncologists only. Radiation therapists can assign resources for both treatment and preparation areas because they could be potentially integrated. Once completed, consider workload model two and the impact to staffing numbers if facilities were to be expanded at the existing tertiary site instead of at a new distributed site. Indicate your response in the third column; again for your own scope of practice only.

	Workload models for radiotherapy services		
	Distributed		
	Basic	*Developed*	*Existing tertiary*
Patient courses (*n*/year)	541	704	704
Linear accelerators	2	2	2
(utilization)	(1.5)	(2)	(2)
Simulator facilities	√	√	√
Dosimetry facilities	√	√	√
Human resources[a]			
Radiation oncologists on site			
Radiation oncologists off site			
Clinical associate on site			
Radiation therapists (treatment) on site			
Radiation therapists (treatment) off site			
Radiation therapists (preparation) on site			
Radiation therapists (preparation) off site			
Medical physicists on site			
Medical physicists off site			
Technical equipment officers on site			
Technical equipment officers off site			
Registered nurses			
Clerical support			
Department managers			

TABLE III Continued

Please use the rating scale to indicate how important the following key features associated with a successful radiation therapy clinic are to you when considering a distributed radiation therapy model.

	Unimportant	*Slightly important*	*Unable to comment*	*Important*	*Very important*
Access	1	2	3	4	5
Quality	1	2	3	4	5
Cost	1	2	3	4	5
Staff continuing education	1	2	3	4	5
Residency program	1	2	3	4	5
University affiliation	1	2	3	4	5
Research program	1	2	3	4	5
Clinical trials	1	2	3	4	5
Radiation therapy school	1	2	3	4	5
On-call service	1	2	3	4	5
Dosimetry facilities	1	2	3	4	5
Simulation facilities	1	2	3	4	5
Complex procedures	1	2	3	4	5
Cutting edge technology	1	2	3	4	5
Comments					

[a] Can assign full-time equivalent, if required.
3D CRT = 3-dimensional conformal radiotherapy; IMRT = intensity-modulated radiotherapy; IGRT = image-guided radiotherapy.

TABLE IV Names and titles of the external experts consulted

Dr. Jean Paul Bahary	Director of Radiation Oncology, Centre hospitalier de l'Université de Montréal, Montreal, QC (May 2006)
Dr. Anthony Whitton	Provincial Coordinator of Radiation Services, Cancer Care Ontario, Toronto, ON (May 2006)
Prof. Geoff Delaney	Director of Radiation Oncology, Liverpool Hospital, Sydney, New South Wales, Australia (March 2007)
Dr. Dwight Herron	Vice Chair, Department of Radiation Oncology, Cancer Centre, University of Pittsburgh Medical Center, Pittsburgh, PA, U.S.A. (July 008)

3. RESULTS

The research team finished the preparatory tables for the survey between May and September 2006. Of the 71 staff members who attended the town hall meeting, 55 (79%) representing 39% of program staff (55 of 140 full-time staff members) completed the survey. The subsequent interviews were held in mid- to late 2007, and the research was collated for synthesis in the fall of 2008 (Tables V and VI).

3.1 Comparing Canadian (Podgorsak) Staff Numbers and Estimates

Using cancer registry data, census data, and the Delaney radiotherapy utilization estimate model [9,10], we showed that Lethbridge could treat 77% and 97% of possible local patients in the basic and developed models respectively. Table V shows a concordance between mean personnel estimates from the staff survey and recommended national personnel guidelines for the basic and developed models. For the basic model, the surveys estimated needing 14.9 full-time equivalents (FTEs), and the national guidelines, 15.3 FTEs; for the developed model, the numbers were 19.5 FTEs and 18.9 FTEs respectively. There were also no significant differences between the national guidelines and the estimated numbers for each professional subgroup.

Interestingly, the personnel estimate for a tertiary expansion within the staff survey (13.7 FTEs) was lower than the number derived from the national guidelines (19.4 FTEs, $p < 0.01$). The survey also showed that research and academic issues were considered less important in a distributed model than in either the basic or the developed

TABLE V Survey results for the three service delivery models

	Service delivery model					
	Distributed				*Tertiary (centralized)*	
	Basic		*Developed*			
Patient courses (*n*/year)	541		704		704	
Patients treated (%)	77		97		100 (assumed)	
	National model	*Staff survey (SD)*	*National model*	*Staff survey (SD)*	*Tertiary expansion*	*Staff survey (SD)*
Human resources[a]						
Radiation oncologists	3.1	3.2 (1.7)	4.0	4.6 (1.8)	3.5	3.1 (0.9)
Radiation therapists (treatment)	6.4	5.9 (1.9)	8.2	7.3 (1.7)	8.4	5.8 (1.2)
Radiation therapists (preparation)	3.7	3.4 (1.6)	4.1	4.7 (1.7)	5.1	2.9 (1.5)
Medical physicists	2.1	2.4 (0.8)	2.6	2.9 (1.3)	2.4	1.9 (0.8)
Total (FTEs)	15.3	14.9	18.9	19.5	19.4	13.7

[a] Mean number.
SD = standard deviation; FTE = full-time equivalent.

option. Comments at the town hall and on the survey made it clear that most staff members supported a distributed model.

3.2 Themes Identified as Important for Developing a Devolved Radiotherapy System

The semi-structured interviews with internal leaders and external experts allowed us to synthesize several overarching themes thought to be critical for successful implementation of a distributed model [11–14]:

- The importance of transparent connections between tertiary and smaller centres
- The essence of balancing complexity of care with access to quality when starting small-city departments (location and size of departments was a driver for this discussion)
- The relevance of training future staff and retaining current staff

Table VI shows the more common issues that were mentioned within these discussions.

4. DISCUSSION

Until recently, Alberta had used a centralized model for radiotherapy delivery, with tertiary departments in Calgary and Edmonton. The province of Alberta has an overall population of 3.25 million people, with almost 1 million outside the large cities being underserved in radiotherapy services. Moreover, since 2000, the two existing radiotherapy departments have grown considerably to accommodate the increased number of referrals.

It became essential to consider moving radiotherapy services into smaller cities for three reasons. First, the continued concentration of radiotherapy in the two large cities over the next 15 years was impractical; departments would be so large as to be ineffective. Second, we are aware that approximately 30% of the provincial population are placed into significant hardship by living more than 100 km from the facilities in these large cities, a situation that is unlikely to improve with a centralization strategy. As of 2008, the province had 5 linear accelerators per million people; Ontario and British Columbia had 6 per million people, and Newfoundland had 7 per million. Third, we were concerned that distance from treatment facilities often forced patients to choose inferior treatments [15,16].

It was proposed that we increase the proportion of patients receiving radiotherapy closer to home by developing 3 small-city radiotherapy departments (sequentially in Lethbridge, Red Deer, and Grande Prairie) between 2010 and 2013 (Figure 1). This proposal was supported by federal government funds specifically meant to improve wait times, allowing the overall cost of this project to the province to be offset by approximately $62 million.

Once that funding was announced, it was important to perform the present study to better understand how departments in those smaller cities would function, so that any barriers to implementation of small-city departments could be removed. The outcomes from the study have allowed us to generate functional plans for Lethbridge and to mitigate potential barriers to recruitment. The Lethbridge centre started treating patients in June 2010. Decisions about caseload, staffing, and required

TABLE VI Themes from the discussions with internal leaders and external experts

Development of an appropriate structure

Sufficient infrastructure to consider this development

It was felt by most discussants that Alberta was well poised to do this and had a network of smaller centres with chemotherapy departments that could be used to develop radiotherapy departments across the province. There was ample evidence showing the importance of expanding radiotherapy into smaller cities to be able to increase utilization rates.

Development of departments with at least 2 machines and a CT simulator

Most discussants were concerned with the single machine unit concepts coming out of Australia and Ontario. The numbers of patients needing treatment in small cities supported 2 or more units, and having more than 1 unit prevents loss of service during maintenance. Given the size of the small cities, with the diagnostic radiology support, and the image guidance needed for treatment, it was proposed that there be CT simulation facilities attached to this department.

The essence of innovative information systems

Given the stated preference for the small and large centres needing to be connected to each other, it was seen as critical to develop systems that allow for rapid transmission of diagnostic and treatment planning data across the province. The need to have an integrated electronic patient record was a priority, as was provision of telehealth services.

Processes and people

Need to determine consensus concerning groups of patients appropriate for consultation and treatment in small centres

Discussants felt it critical that all centres be connected in a network approach to service delivery.

Tertiary centres would form the hub of the network and have the ability to treat any patient referred to them, with the smaller centres able to deliver high-quality radiotherapy for patients deemed appropriate (approximately 85% of cases).

Need to promote local presence in the community but be connected to tumour group colleagues across the province

Flowing from the concept of connecting the hub (tertiary) to the spokes (smaller centres), it was considered essential to have local consultants function optimally in their community, but be accountable to colleagues in tumour groups. It was strongly recommended that there be local medical oncologists in the small centres as well.

Importance of having local expertise in dosimetry and medical physics

Although a certain amount of support could be obtained through centralized resources, the quality of treatment is contingent on dosimetrists and medical physicists having a presence in smaller centres. Radiation safety would require this as well.

Development of an organizational framework for setting and delivery of quality standards

A network of centres across the province would be the desired framework, so that clinical and technical standards are established and adhered to. Furthermore it was recommended that a provincial radiation services leadership structure be introduced that would allow all radiotherapy-related professions to contribute in a meaningful way.

A proactive approach is needed to train sufficient graduates to support our centres, and it is important to market recruitment aggressively

A personnel plan for a 15-year period should be developed using the national society ratios, and a gap analysis should be performed to ensure knowledge of hoe many positions to train into.

System targets need to be set to drive performance

Wait times, utilization rates, and other indicators of system performance should be agreed upon and collected to ensure optimal productivity.

Human resource support needs to be transparent

Discussants suggested that one of the more difficult organizational barriers was determining how support for vacation, illness, and vacancies in the small centres would be dealt with. Central resources need to be available for smaller centres so that their staff are allowed to exercise options for vacations and so on.

Local support for other functions

Discussants were quick to point out that, at a minimum, there needed to be availability of clinical support personnel such as social work, clinical trials, and rehabilitation staff.

Local environment

The local community should support this development

One of the more contentious items was the importance of local community support for integration of radiotherapy into the region. Local support would involve provision of space for radiotherapy facilities adjacent to the hospital, subsidized accommodation facilities for patients forced to travel, volunteer services, access to other resources in the community, and encouragement of local youth to train for one of the radiation disciplines.

The desirability to live in this community should be considered

Recruitment and retention of qualified personnel is far more likely if the local community has reasonable housing, good educational facilities, adequate recreational opportunities, and a stable public transport system.

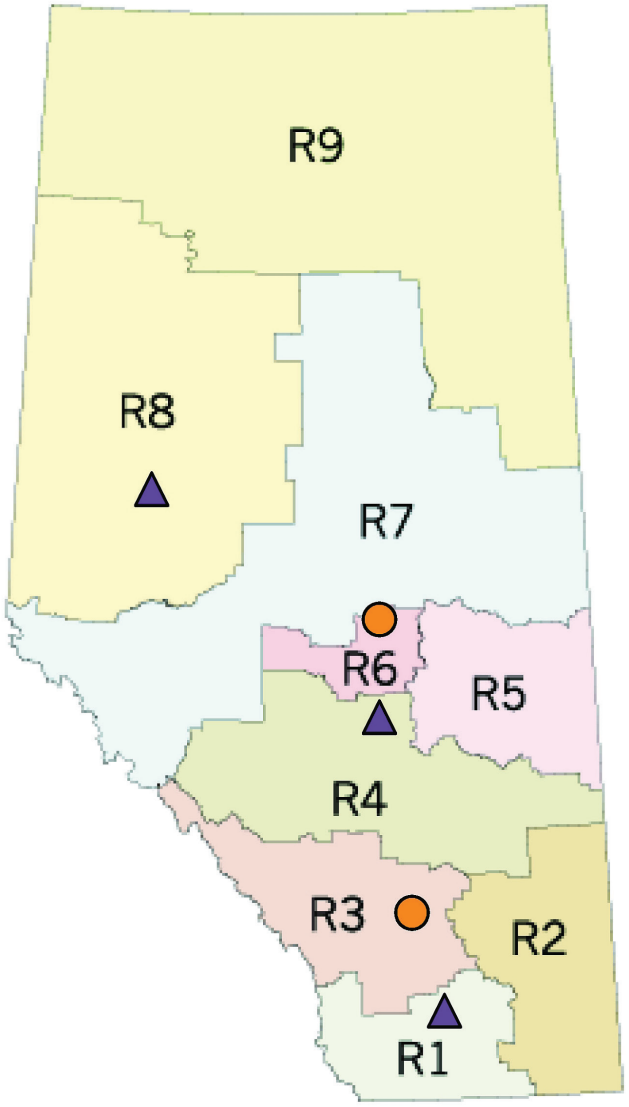

FIGURE 1 Alberta Health Regions: existing tertiary (filled circles) and proposed small-city (filled triangles) radiotherapy departments as of 2007.

infrastructure have been used to develop a strategic plan for all 3 small departments.

Internal and external discussants all supported the decentralization of radiotherapy—more specifically, they favoured the developed over the basic model. Initial conversations before the survey was conducted indicated that staff were concerned about the potential difficulty of attaining a level of quality and staffing in a small-city department that would be similar to that in the tertiary centres. We believe that support for the developed model demonstrated in the survey was partly a result of our ability to validate successful implementation of similar models in other Canadian jurisdictions. The strong support for a developed model despite the financial benefits of maintaining a centralized model was also interesting.

Our research shows the importance of several drivers thought critical for the successful implementation of small-city radiotherapy departments. Failure to address those drivers is likely to result in failure to maintain quality and safety in cancer care across the province.

4.1 Driver 1: Connectedness to Tertiary Sites and Audit Mechanisms

The interviews, group discussions, and staff surveys all indicated that the link between tertiary and smaller cities is an important element that requires careful attention if radiotherapy is to be safely devolved [15,17]. This link is seen to be critical for maintaining quality of care and allowing peripheral departments to feel supported. Several of the external informants expressed viewpoints such as these: "Without links with a tertiary centre, this will not be attractive to younger graduates." "You will be unable to support a clinical trials agenda without this link." "You will find that smaller centres take their lead in using provincial guidelines from academics in the larger centres."

Our interviewees and discussion groups suggested that small departments should have autonomy in service delivery, but that strong interdependence is required between small departments and tertiary centres if quality standards are to be maintained across the province. Furthermore, unless support from tertiary centres is tangible, small departments will find it difficult to retain staff. Finally, such departmental interdependence will foster opportunities for staff to participate in the academic aspects of care and for younger staff to be considered for transfer to a tertiary site when they demonstrate academic prowess. The possibility for advancement encourages the recruitment of quality applicants to positions in small-city departments. In discussing how such a relationship between centres could be secured, we believe that a formal network arrangement is a superior model. That model allows for establishment of, and adherence to, common clinical and technical guidelines. The elements that need to be addressed within such a network include reporting relationships, functional electronic pathways, innovative telehealth, and a transparent audit mechanism.

4.2 Driver 2: Factors Determining the Size and Location of Departments

There are several issues connected with sizing and siting small-city departments [17–20]. Electronic platforms for health records, transmission of imaging data, and availability of planning systems province-wide are critical concerns. A second broad area needing a clear decision is the importance of defining the acceptable minimum size of a small-city department. An executive decision of this kind seemed to drive the model in a significant

way, affecting the overall framework. For example, the Australian and French experiences suggest that single-machine units (SMUs) are safe and practical, but Canadian provinces are more likely to select departments with more than 1 accelerator.

Participants in Canada suggested that this difference is based on the philosophy that larger departments are associated with greater stability in retention of staff and an ability to offer local treatment to more patients than SMUs can. Such a model would contain costs relative to the SMU, but would force more travel for some patients—which has certainly been the experience in larger provinces such as British Columbia and Ontario.

With that backdrop, we focused on determining whether support existed for a SMU approach to service delivery in Alberta [14,18]. Most internal respondents felt that having more than 1 unit is always optimal because of greater cost effectiveness, benefits to retention of staff, and mitigation of treatment delays when a single unit has to be taken down for service or repairs. International experts were more likely to support the establishment of SMUs, but only in the presence of a strong connection with a tertiary facility. The Canadian philosophy of developing larger departments also appears related to previous resistance to devolving care outside large cities in this country. Many mid-sized cities can now easily can support departments with more than 1 accelerator. After radiotherapy is established in more of these mid-sized cities it is likely that SMUs will be considered again. A trend of this kind is already occurring in Ontario and Quebec.

Our compromise has been to choose a geographic demand model to drive discussion. We found that this approach, and a focus on facilities that already provide chemotherapy to local patients, can increase access to radiotherapy closer to home and justify making departments large enough to be practical to develop. In our decisions of when to develop each department, we included factors such as community acceptance, distance from a tertiary site, and resources required to retain staff in a local community.

Using this model, we believe that Lethbridge, Red Deer, and Grande Prairie will be viable sites for small departments with a minimum of 2 linear accelerators in each centre. There was support from respondents for a CT simulation function rather than a conventional simulator and for a provincially integrated planning approach. Within the realm of modern radiotherapy planning, it is important that this function be networked, to ensure that smaller departments have the ability to offer conformal and intensity-modulated radiotherapy.

4.3 Driver 4: Personnel Issues

Serious concerns have been raised about the ability of our system to attract and retain an appropriate workforce for small departments [8,21]. This concern relates partly to Canada's cancer specialty disciplines not identifying national personnel guidelines for non-academic clinician workloads. In examining the staff survey results, confusion over this issue was apparent. Most guidelines suggest that academic centres require more staff, but our staff survey demonstrated that staffing for academic centres is underestimated. We hypothesize that staff probably recognized that academic institutions have more than one funding source, with university funding of educational and research activities not required in a clinically focused model. We also believe that this finding shows an understanding on the part of staff that establishing any new department requires a baseline staff cohort, with staff-to-patient ratios declining once the baseline is achieved.

Other staffing concerns for devolved radiotherapy services include these:

- The lack of a consistent national supply of medical physicists and radiation therapists, so that reliance can be placed on that track to provide personnel. We decided to advertise both nationally and internationally, and to develop training positions in our own programs to ensure a sufficient supply of professionals in those domains.
- The need to have training approaches that attract local students from the communities in Lethbridge, Red Deer, and Grande Prairie to pursue training in the needed disciplines.
- The importance of selecting sites in which the local community culture is attractive and encourages retention and recruitment to the new centres.
- The need for adequate support for smaller operations, meaning that tertiary specialists are willing to help out when personnel numbers are compromised.

The selection of the developed model means that we will have to train a significant number of radiation therapists and medical physicists. It remains unclear whether treatment preparation areas require separate training, but we will ensure that radiation therapists and medical physicists in selected small cities have the ability to cover this important function.

5. CONCLUSIONS

This study generated several important qualitative findings that have assisted in our discussions with government about the future model:

- The environmental scan of opinion leaders gave credibility to the Alberta Cancer Board's decision to expand radiotherapy services outside Edmonton and Calgary. The strong support for moving radiotherapy services closer to patients,

without compromising cost effectiveness, is strong endorsement. That the scan demonstrated successes in other provinces was helpful. The need to expand into other cities is particularly important if we are to achieve a radiotherapy utilization rate of 45%–50% of incident cases in Alberta.

- Our staff survey findings assisted discussions about staffing in smaller cities. As a result, we can feel confident that the functional planning and budgeting templates could use national guidelines to define equipment and personnel standards in Lethbridge, Red Deer, and Grande Prairie. All those departments will launch (in 2010, 2011, and 2013 respectively) with 1 CT simulator and 2 linear accelerators. They all will be expected to offer state-of-the-art treatment, with linkages to central planning resources in Edmonton and Calgary. The treatment planning system, large equipment, electronic record, and treatment standards will all be consistent throughout the network.
- Our work also demonstrated the importance of connectedness between the various sites and the need to be proactive about training staff for the new departments. Our centres have already responded to the personnel issues by funding increased training positions for more therapists and medical physicists. We are hiring radiation oncologists both from our own training programs and from across North America to function in clinical roles in the newer departments. Interest in the network concept that allows younger staff to practice high-quality radiotherapy has been tremendous, and because remuneration is salary-based, it has not been an issue for potential recruitment.

Our ultimate vision is to provide cost-effective, optimal care for cancer patients as close to home as possible. We believe that a distributed model will also reduce the size of our tertiary centres so that they can focus on the important role of performing research and establishing provincial standards. We highly recommend such an approach for other jurisdictions, because it allows for local buy-in from staff.

6. CONFLICT OF INTEREST DISCLOSURES

The Alberta Cancer Board provided grant funding to this study. No financial conflicts of interest exist.

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